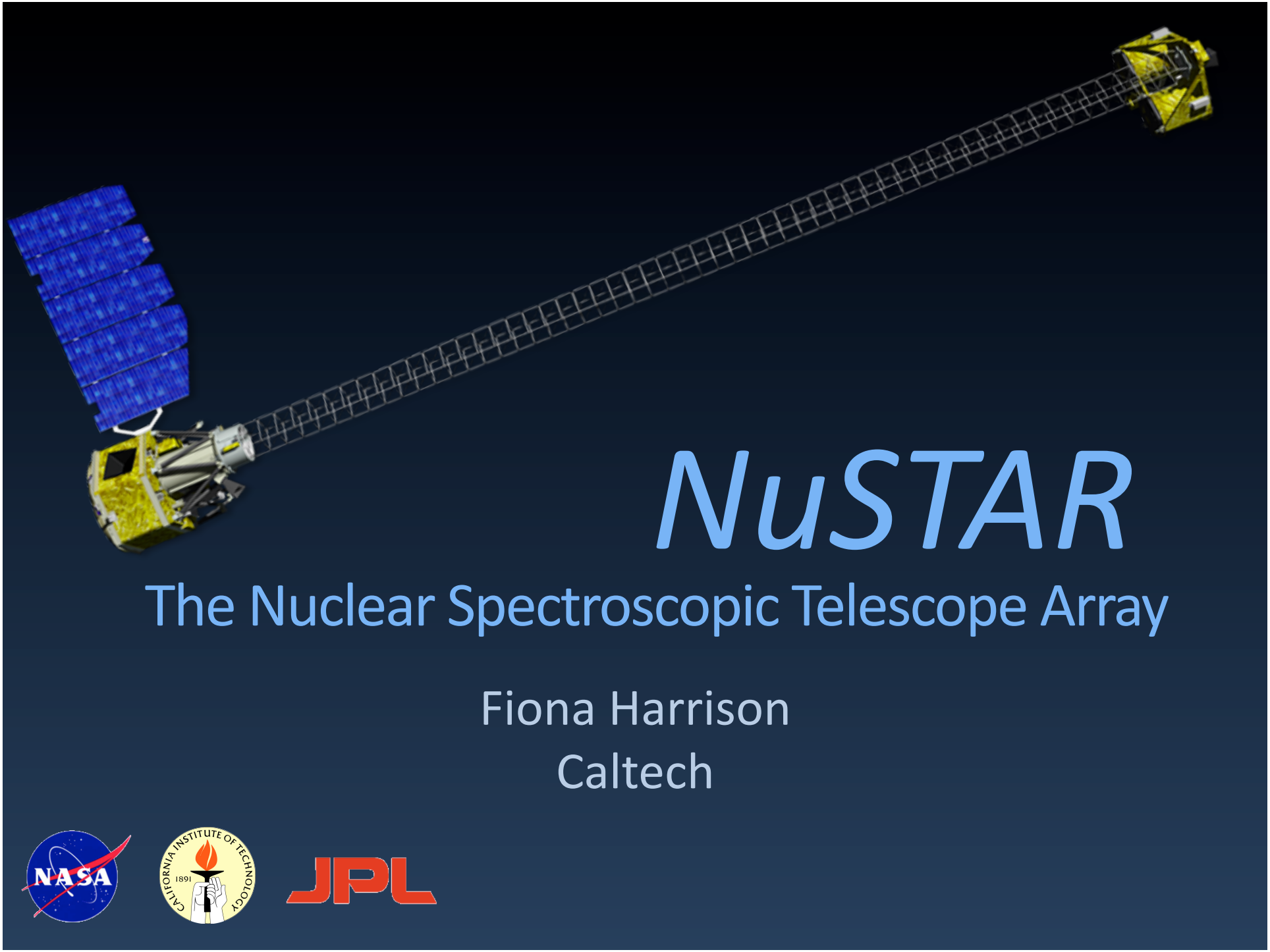
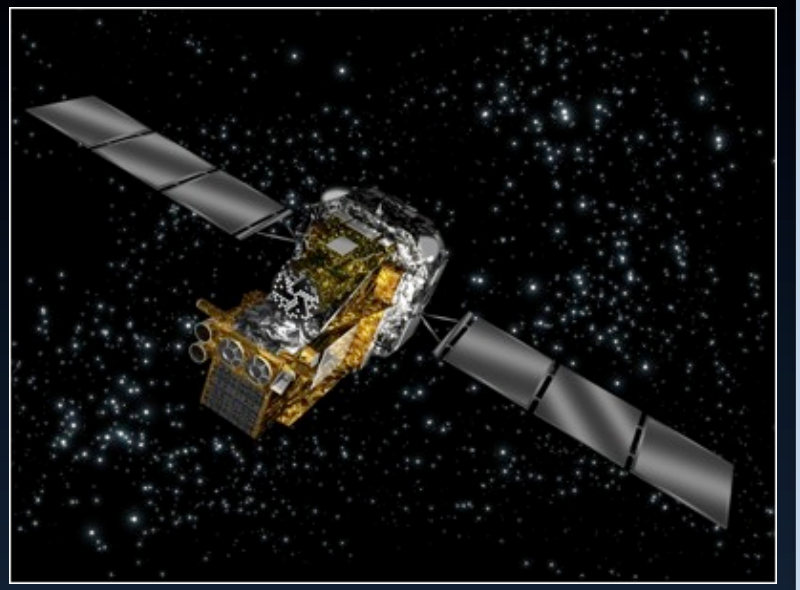


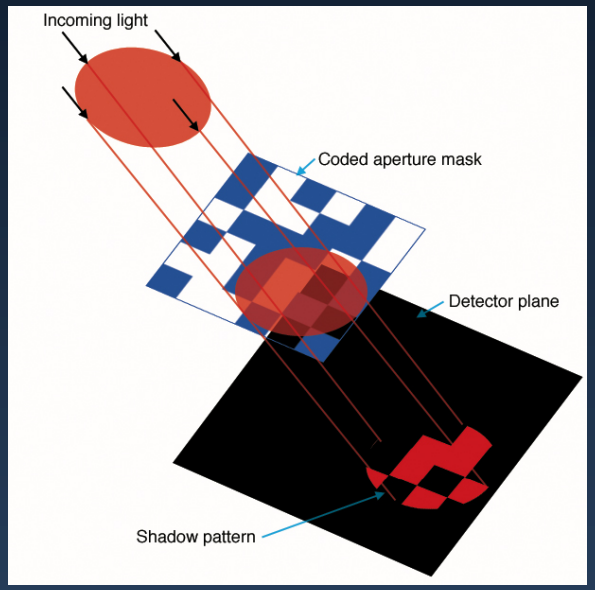
NuSTAR

The Nuclear Spectroscopic Telescope Array

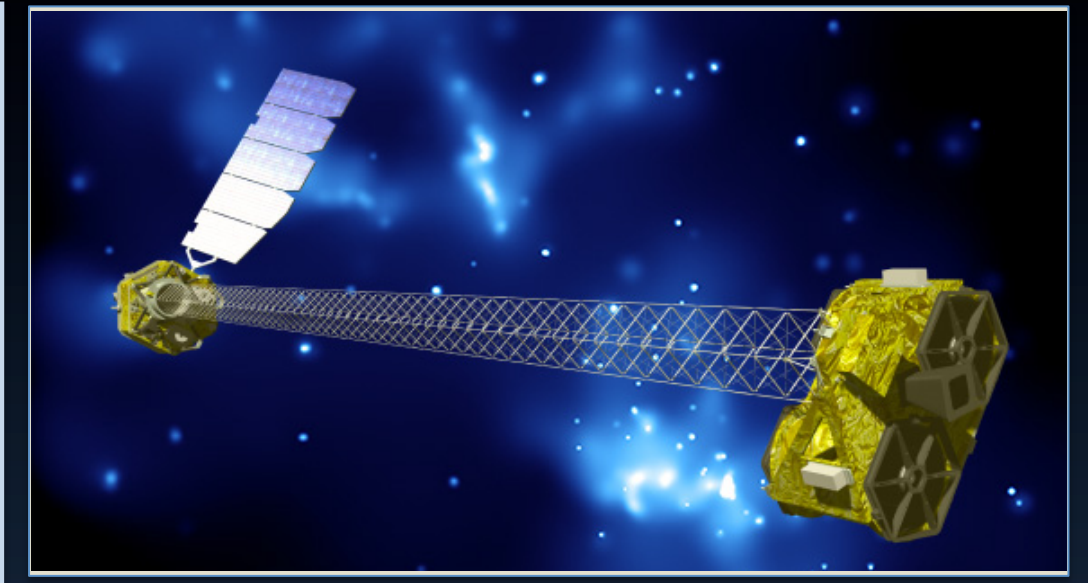
Fiona Harrison
Caltech

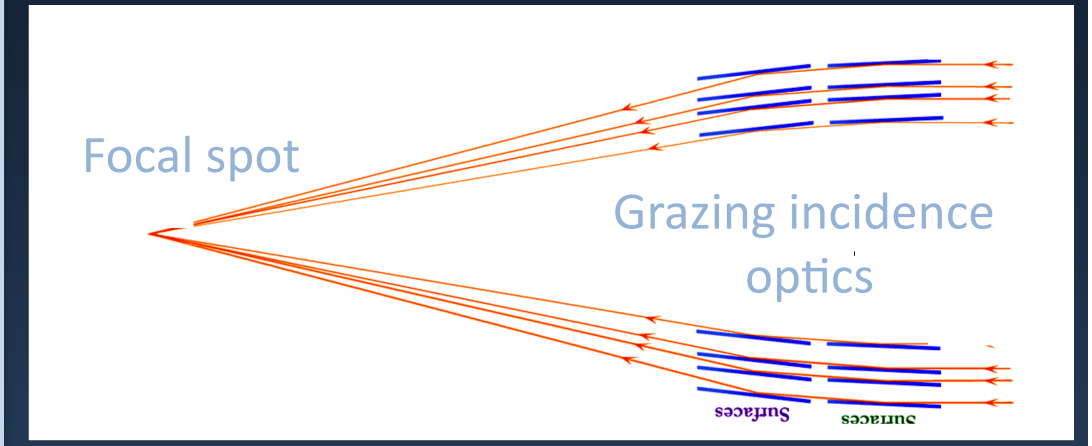
INTEGRAL, Swift BAT

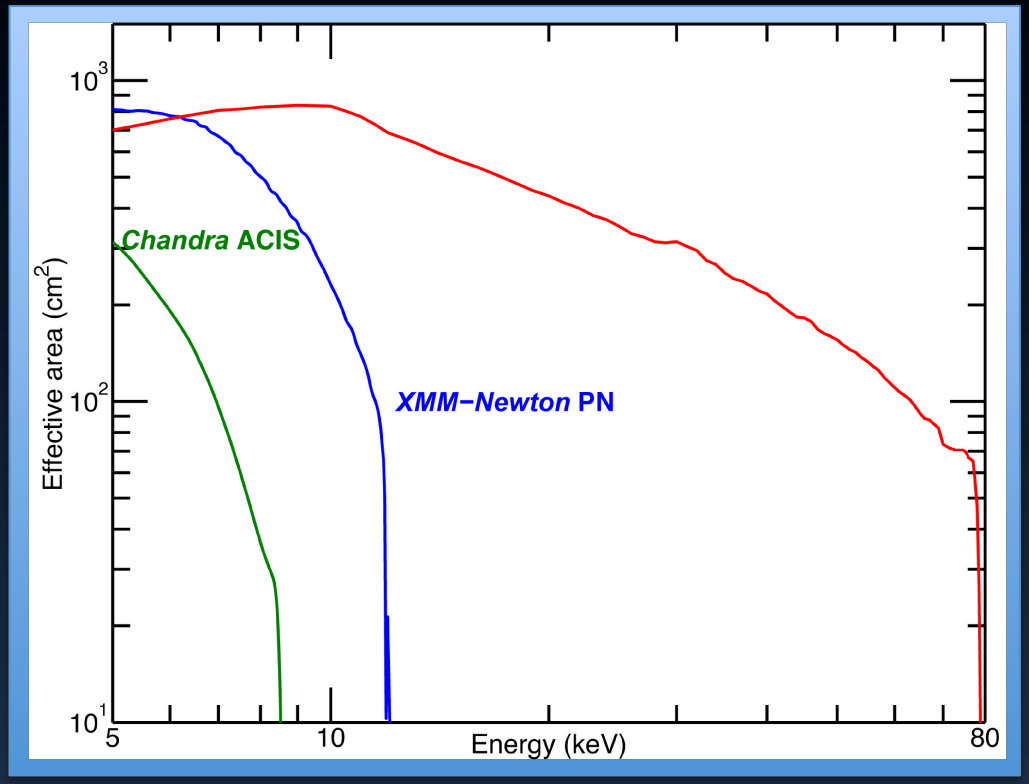




NuSTAR







NuSTAR two-telescope total collecting area

Satellite (instrument)	Sensitivity
INTEGRAL (ISGRI)	~0.5 mCrab (20-100 keV) with >Ms exposures
Swift (BAT)	~0.8 mCrab (15-150 keV) with >Ms exposures
NuSTAR	~0.8 μCrab (10-40 keV) in 1 Ms

Sensitivity comparison

1 Ms Sensitivity

3.0 x 10^{-15} erg/cm^2/s (6 – 10 keV)
1.2 x 10^{-14} (10 – 30 keV)

Imaging

HPD	~50”
FWHM	10”
Localization	2” (1-sigma)

Field of View

FWZI	12.5’ x 12.5’
FWHI	10’ @ 10 keV
	8’ @ 40 keV
	6’ @ 68 keV

Timing

relative	100 microsec
absolute	30 msec

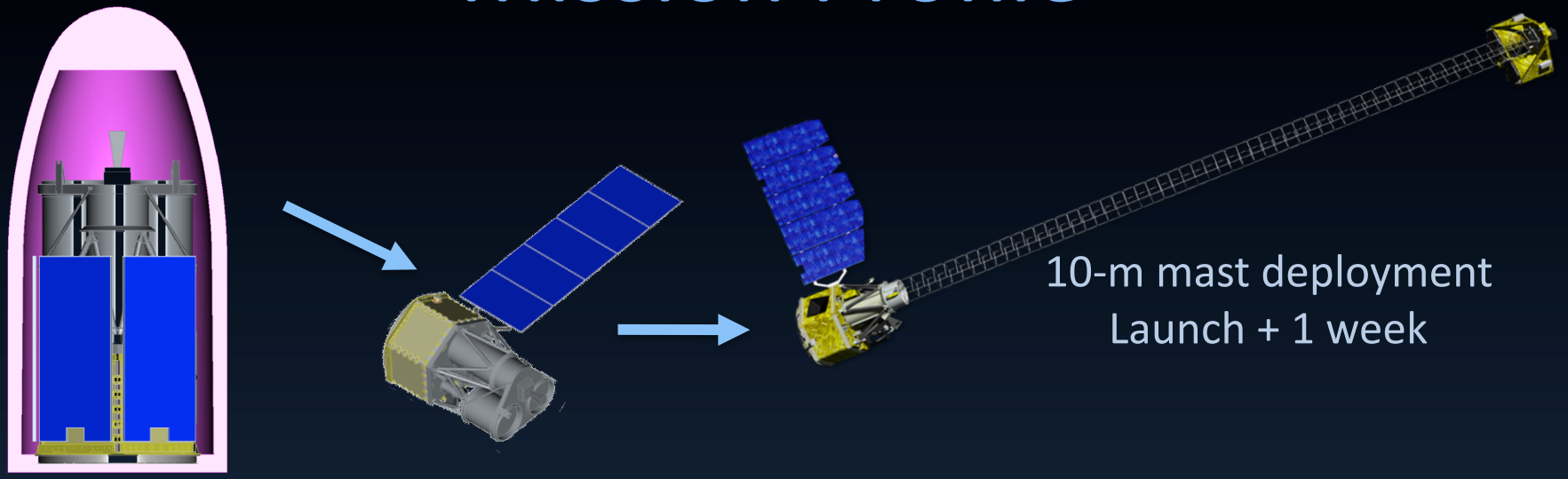
Spectral response

threshold	2.5 keV
ΔE @ 6 keV	0.6 keV FWHM
ΔE @ 60 keV	1.0 keV FWHM

Target of Opportunity

response <24 hr (reqmt)
typical 6-8 hours
85% sky accessibility

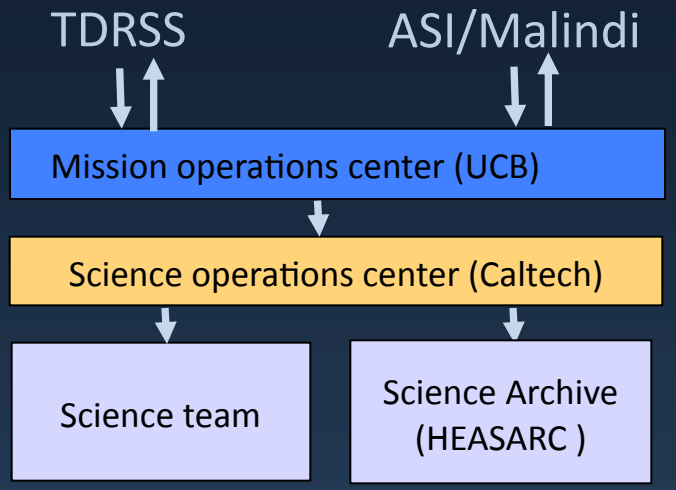
Mission Profile



10-m mast deployment
Launch + 1 week

Pegasus XL
Feb 3 2012

6° inclination 550 x 600 km
Low background
55% observing efficiency

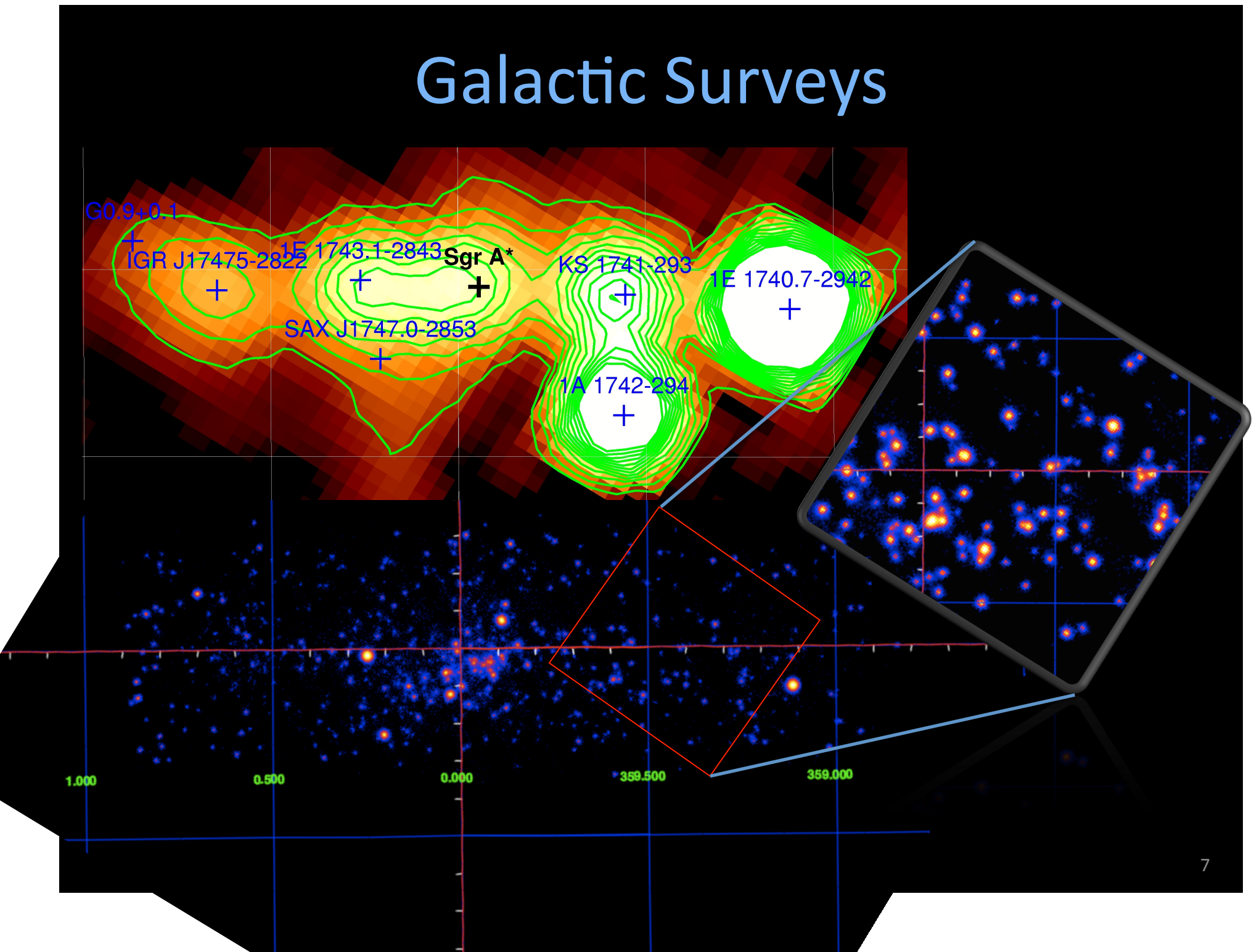


2-year baseline science mission

Baseline Science Mission

Key science goal	Observations	Time (weeks)
Locate massive black holes	Deep and wide-field extragalactic surveys (GOODS S, COSMOS, BAT-shallow)	23
Study the population of compact objects in our Galaxy	Survey Galactic Center and other fields of varied ages (spiral arms, bulge)	20
Explosion dynamics and nucleosynthesis in core collapse and 1a SNe	Pointed observations of young ($\tau < 500$ yr) remnants – Cas A, SN1987A, GX1+9 ToO observations of nearby SN1a	22
Understanding relativistic jets in supermassive black holes	Contemporaneous multiwavelength observations of GeV/TeV blazars	6
Other Objectives	Observations	Time
Varied	In final planning stage	33

Galactic Surveys



Extragalactic Surveys

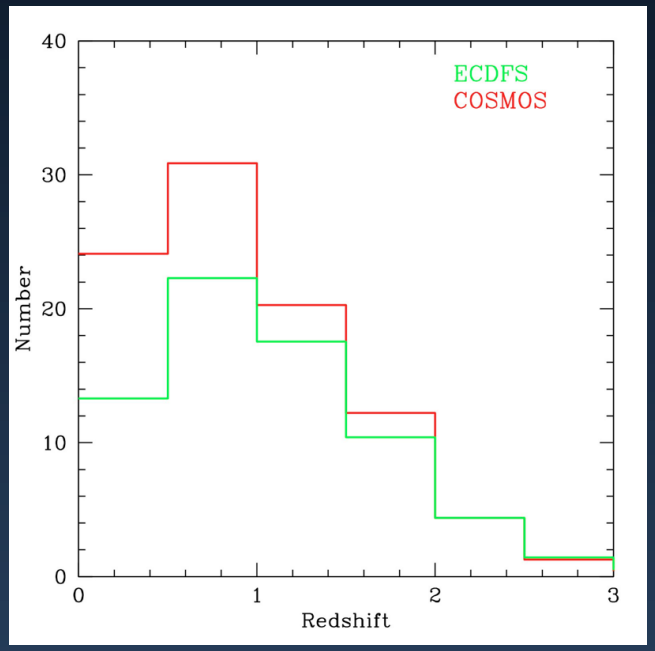
First sensitive surveys 10 – 30 keV

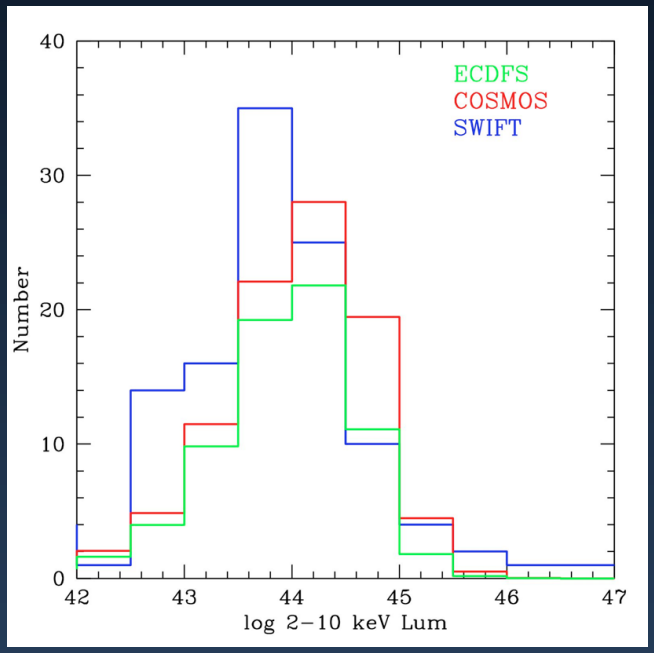
- What AGN populations dominate the background at 30 keV?
- How were black holes growing as a function of redshift, independently of absorption?
- Does the obscured AGN fraction increase with redshift?
- Do the most heavily obscured AGNs reside in specific host-galaxy environments?

See Ballantyne et al. 2011 ApJ

Extragalactic Surveys

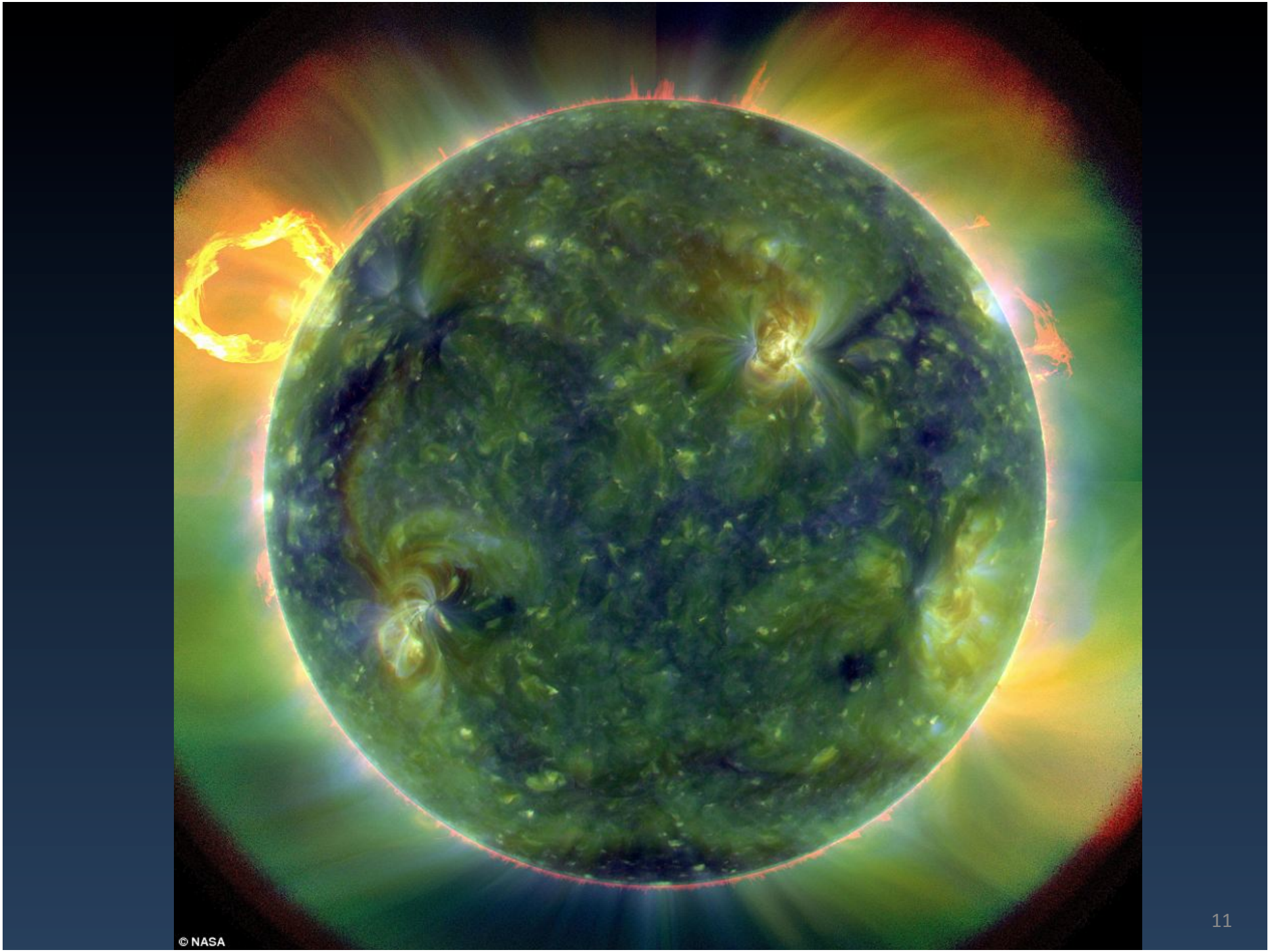
Field	Area	Exposure	Depth (10 – 30 keV) erg/cm^2/s
E-CDFS	0.3 deg^2	200 ksec	2 x 10^{-14}
COSMOS	1 deg^2	50 ksec	4 x 10^{-14}
BAT shallow	3 deg^2	7 ksec	1 – 1 x 10^{-13}



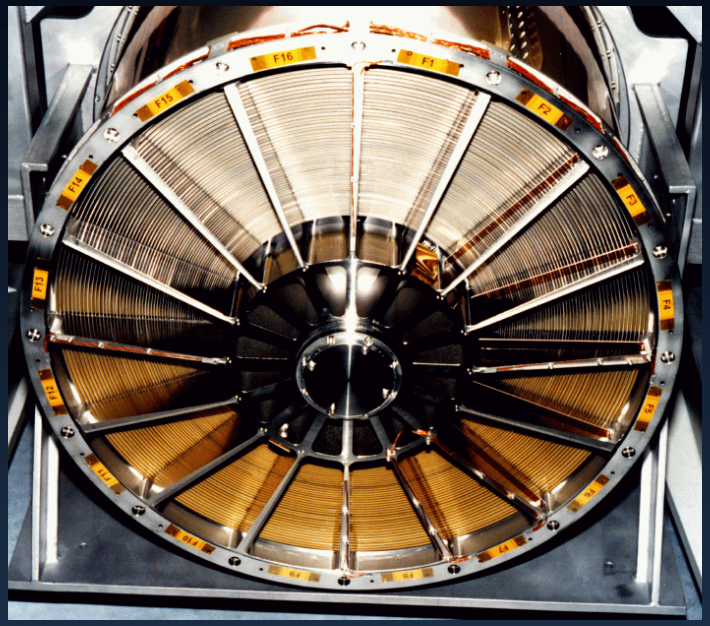


Additional Science

- Supernova remnants
- Planetary Wind Nebulae
- Supernova Ia ToO
- Magnetars
- X-ray Binaries
- Pulsars
- Gamma-ray binaries
- Flaring protostars
- Sun
- AGN physics (corona temperature)
- Ultra-Luminous Infra-Red Galaxies (ULIRGs)
- Compton-thick AGN
- Starburst galaxies
- Galaxy clusters
- Blazars
- Radio galaxies
- Ultra-Luminous X-ray Sources

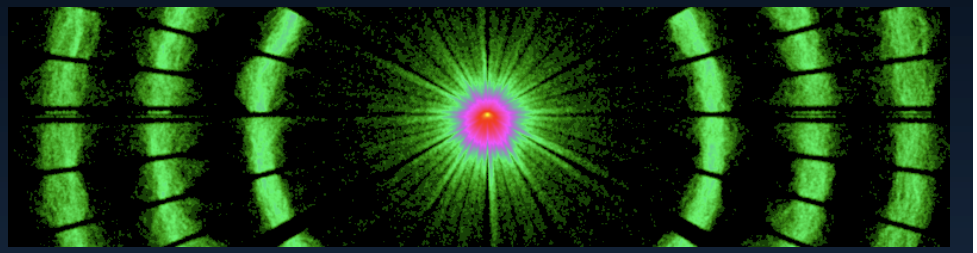

© NASA

Optics

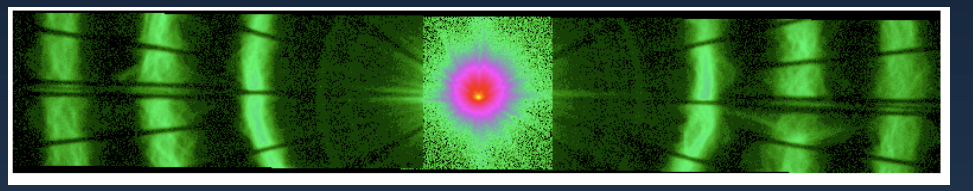


Depth-graded multilayer coated optics – 133 shells

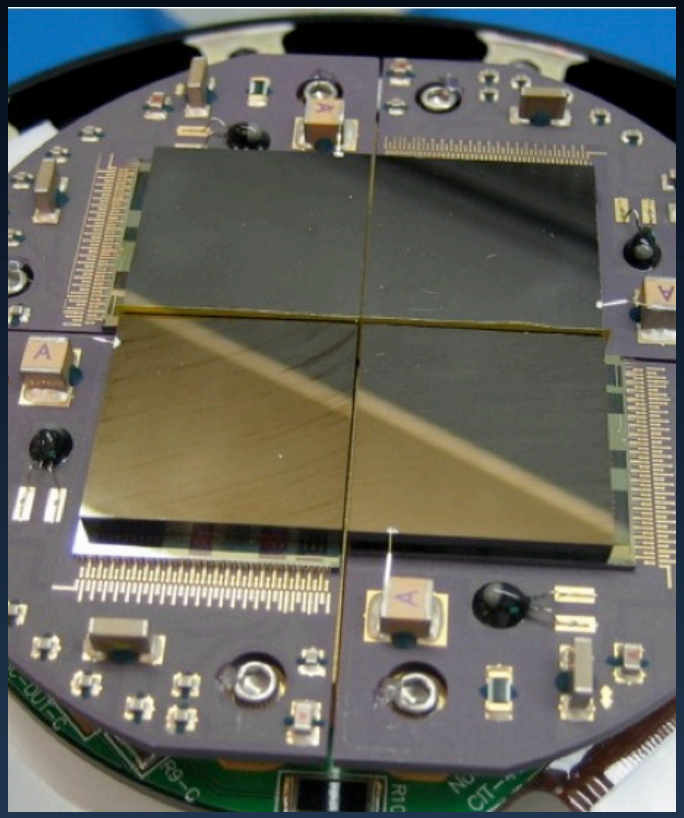
Simulated

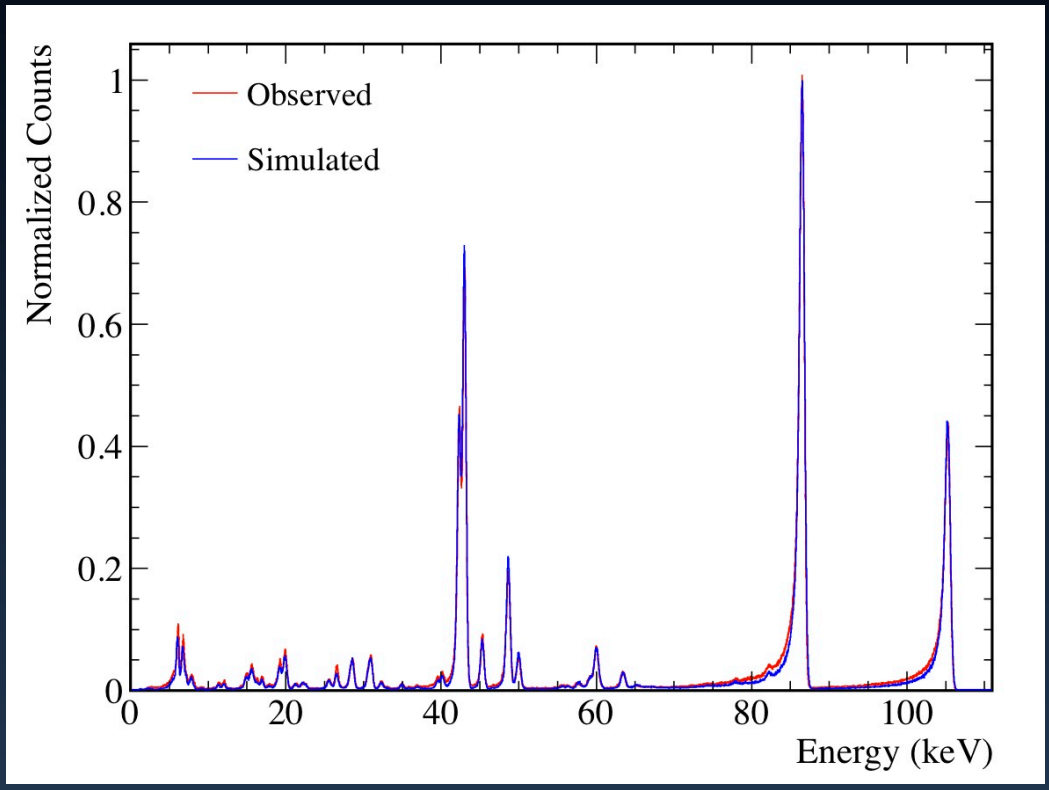


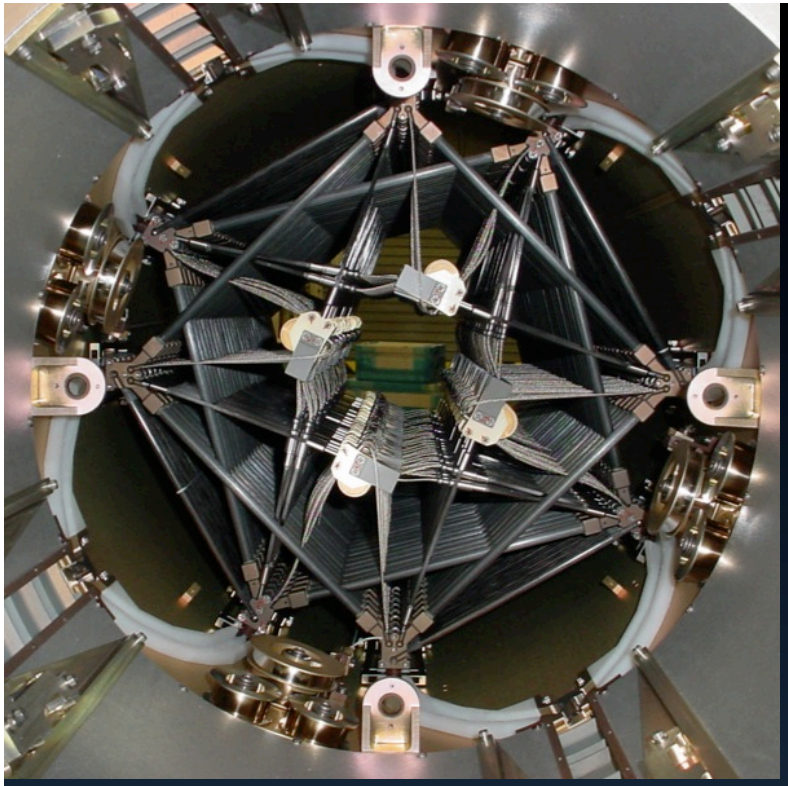
Calibration data

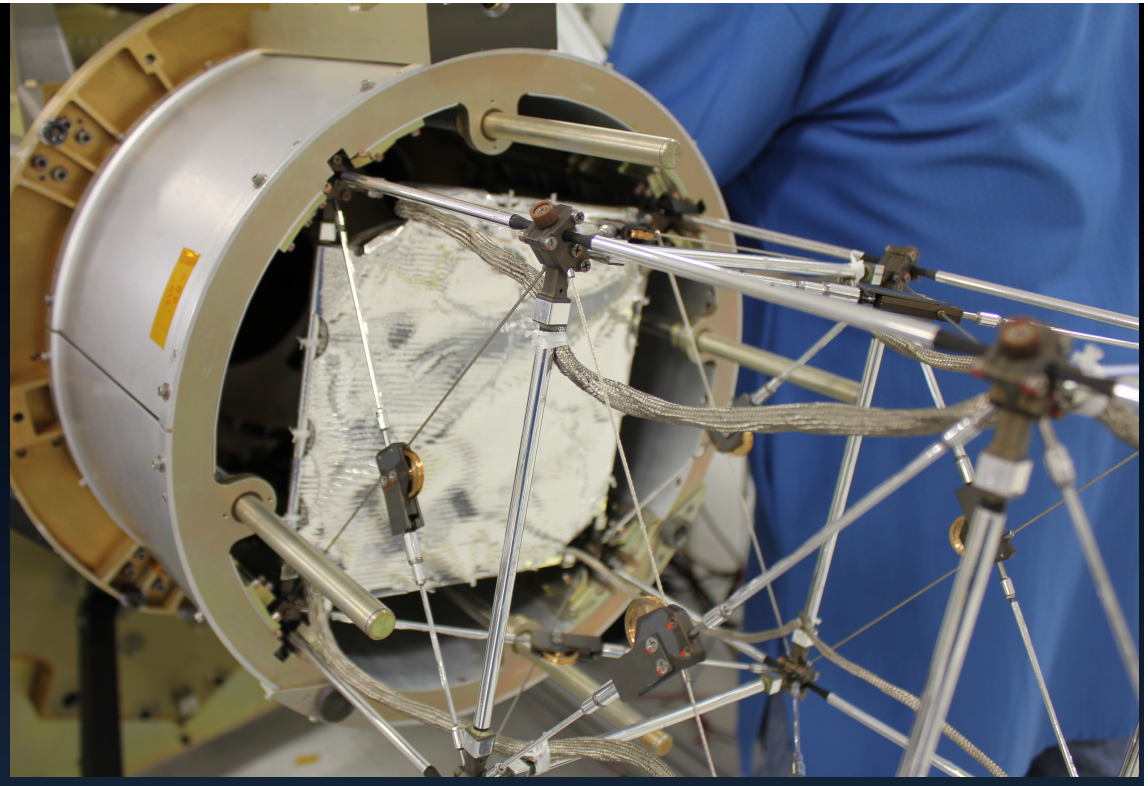


Focal Plane



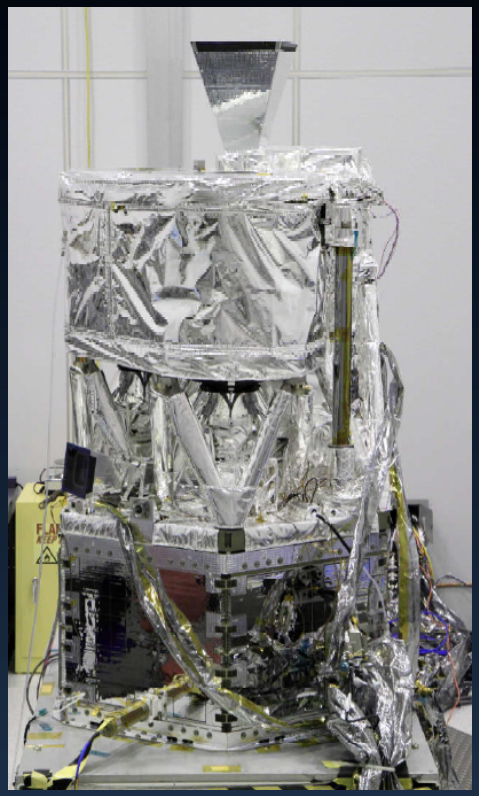

Normalized Counts
Observed
Simulated
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
Energy (keV)



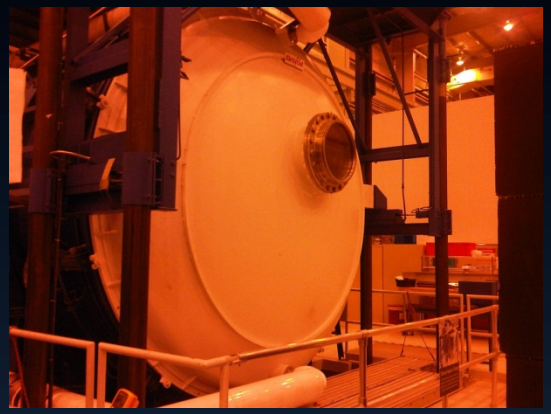



CAUTION
CAUTION

Project Status



NuSTAR observatory

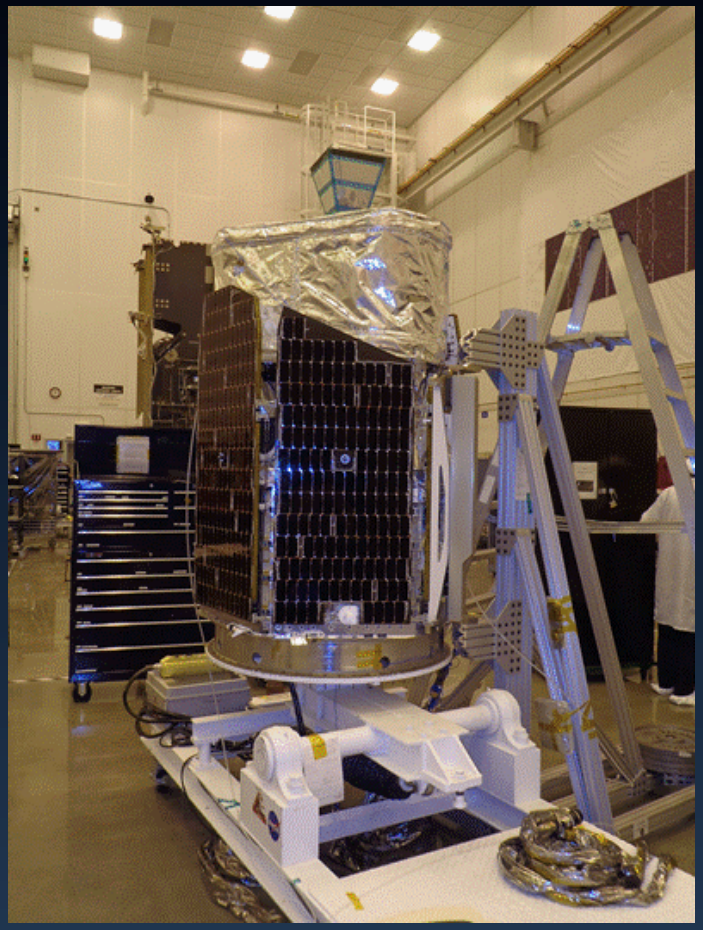


Thermal vacuum test

Vibration test

Project Status

Acoustics test



NuSTAR observatory
after shock test

Remaining I&T Tasks

- First motion test
  - Started 10/14. Test aborted – reschedule 10/24
- EMI/EMC test
- Final flight software load
- Comprehensive performance test #3
- Ground station (Malindi) compatibility test
- Solar array installation and test
- Mass property measurement
- Packing, inspections, and shipping

Issues and Concerns

- First motion test
  - Procedural error caused potential overstress of SC switch circuit
- Launch vehicle schedule
  - Review of Pegasus base ring separation system following Glory (Taurus) failure
- Launch no earlier than March 3 2012 (was Feb 3 2012)
  - Pending resolution of launch vehicle and range availability
- Timing of Senior Review

Summary

- Observatory is making good progress in I&T
  - Only significant issue is stress analysis of SC switch circuit
- Launch vehicle situation is (almost) resolved pending range availability
- International science community is eager and engaged
    - Large international team
    - Two (accepted) synergistic proposals with Chandra – one large, one visionary
    - Five joint XMM proposals submitted
    - Top-ranked heliophysics APRA accepted for solar data analysis
- Looking forward to Spring 2012 launch!